

# 14C TESTING BOTTLE, TESTING DEVICE AND METHOD, SAMPLING AND PREPARATION SYSTEM AND METHOD

## CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is based on, and claims priority from, Chinese Patent Application No. 201711154536.9, filed on Nov. 20, 2017, entitled “<sup>14</sup>C testing bottle, testing device and method, sampling and preparation system and method”, the disclosure of which is hereby incorporated by reference herein in its entirety.

## TECHNICAL FIELD

[0002] The present invention involves the field of isotope detection, in which the <sup>14</sup>C testing bottle, <sup>14</sup>C testing device and its testing method, sampling and preparation system and its implementation method are disclosed.

## BACKGROUND ART

[0003] At present, coal is still the main fuel in the power industry. With the social development and economic improvement, there is a sharp increase of demand of electric power, and a sharp decrease of coal storage, and also huge damage to our environment.

[0004] However, biomass is a renewable energy containing carbon. It is the characteristics of carbon neutral make biomass energy be applied for replacing part of fossil energy represented by coal, and reducing emission of carbon dioxide to mitigate greenhouse effect. Biomass and coal co-fired has been confirmed as an excellent method for biomass energy large-scale utilization by existing technology. It is an efficient and environmental method for producing energy, which can not only decrease the emission of pollution and carbon dioxide, but also utilize the biomass fuel with low heat value efficiently.

[0005] However, lacking of effective and reliable detection technology and device of biomass blending rate make it unable that the government formulate standards and policies for coal and biomass co-fired power generation subsidies, which limits the development of co-fired power generation technology and its market development in China.

[0006] Radiocarbon(<sup>14</sup>C) is a radioactive isotope of carbon, which was first discovered by Martin Kamen and Sam Ruben at the Radiation Laboratory of UC Berkeley in Feb. 27, 1940.

[0007] The cosmic rays hitting nitrogen atoms in the atmosphere make the <sup>14</sup>C production. The living creatures’ <sup>14</sup>C radioactivity is consistent with the atmosphere level, because of the atmosphere carbon cycle. However, the coal’s <sup>14</sup>C radioactivity decays mostly, because of being buried deep in the ground for millions of years. So, the power station burn the biomass or not, and how much their burned, in other words, how is the blending ratio could be known by sampling the flue gas in the boiler flue of coal and biomass co-fired power station and measuring the <sup>14</sup>C in the carbon dioxide.

[0008] The technique based on the radiometric dating of <sup>14</sup>C isotopes was first applied for research of archaeology and geology, which is an effective method for biological component identification at present. Differ from the situation of garbage incineration power station, the supply of bio fuel is affected by season, which make the biomass blending rate

is no more than 5% in the coal and biomass co-fired power station. While the biomass blending rate is low, accelerator mass spectrometry (AMS) is the most accurate detection method for <sup>14</sup>C radioactivity, but the equipment is too expensive to be popularized.

[0009] In the prior art, there are also some methods to measure the <sup>14</sup>C in the carbon dioxide by using scintillation counter. For example, the prior art attempts to obtain carbon dioxide by calcium carbonate suspensions or other absorbents, then count. However, under the condition of low blending ratio, the required detection accuracy can’t be achieved.

[0010] When detected by liquid scintillation counters, enough carbon contents in sample of unit volume are required to reach certain accuracy, which only could be satisfied by benzene synthesis formerly. However, the process of benzene synthesis from carbon dioxide is very complex, and the problems of low conversion rate and long sampling preparation time exist.

## SUMMARY OF THE INVENTION

[0011] The exemplary embodiments of the present invention provide a <sup>14</sup>C testing bottle, a <sup>14</sup>C testing method, a sampling and preparation system and method, for measuring the <sup>14</sup>C content in the carbon dioxide sample rapidly.

[0012] An exemplary embodiment of the present invention provides a <sup>14</sup>C testing bottle including a pressure-bearing shell and a sample bin positioned in the pressure-bearing shell, a cavity is arranged in the sample bin and the <sup>14</sup>C testing bottle is provided with an injection port connected to the cavity. Wherein, the sample bin diffuses the light produced in the cavity.

[0013] At least part of the sample bin is transparent, an optical fiber channels is set on the pressure-bearing shell, one end of the optical fiber channel is connected with an external scintillation counter, and the other end of the optical fiber channel is connected with the transparent part of the sample bin.

[0014] An exemplary embodiment of the present invention provides a <sup>14</sup>C testing device, including an optical fiber, a scintillation counter and the <sup>14</sup>C testing bottle. An exemplary embodiment of the present invention provides a <sup>14</sup>C testing method, which including the following steps:

[0015] Mixing step: mixing up liquid carbon dioxide or supercritical carbon dioxide and scintillator in the <sup>14</sup>C testing bottle, then set it in dark condition for a preset standing time.

[0016] Counting step: inserting one end of the optical fiber into the optical fiber channel of the <sup>14</sup>C testing bottle, connecting other end of the optical fiber to the scintillation counter, and then start counting.

[0017] wherein, the one end of the optical fiber is inserted into the optical fiber channel, and the other end of the optical fiber is connected to the scintillation counter.

[0018] By setting a pressure-bearing shell outside the sample bin, the carbon dioxide in the cavity of the sample bin can be kept in a relatively stable phase state, so that the carbon dioxide can be fully mixed with the scintillator. By setting the cavity which can generate diffuse reflection, the high-energy electrons decay from the <sup>14</sup>C in the carbon dioxide can collide with scintillator monomer, so that the scintillator monomer is in the excited state. When the scintillator monomer is de-excitation, a photon with a wavelength of about 380 nm will be generated. These photons can